Subchapter 7 STORMWATER MANAGEMENT

5:21-7.1 Stormwater Management: Scope

(a) Stormwater management measures meeting the requirements of this subchapter shall be provided for major developments. Stormwater management systems prepared by design engineers shall emphasize a natural, as opposed to an engineered, drainage strategy. To the maximum extent practicable, stormwater management standards shall be met by incorporating nonstructural stormwater management strategies into a design. Where more than one design or method may be used to comply with the rules, the choice of design approach and the methods used shall rest with the design engineer.

1. For projects that fall below the threshold of major development, as defined, a municipality may require, by ordinance, the control of runoff rate and routing from any site that is the subject of a site plan or subdivision application.

(b) The applicability of a natural approach depends on such factors as site storage capacity, open channel hydraulic capacity, and maintenance needs and resources. Applicability of a stormwater approach also can be limited by regulatory constraints that govern certain structures (for example, dams) or areas (for example, development in a floodplain or wetland).

(c) The person submitting the application for review shall identify the nonstructural strategies incorporated into the design of the project. If the applicant contends that it is not feasible for engineering, environmental, or safety reasons to incorporate any nonstructural stormwater management strategies, identified in (d) below, into the design of a particular project, the applicant shall identify the strategy and provide a basis for the contention of infeasibility.

(d) Nonstructural stormwater management strategies incorporated into site design shall:

1. Protect areas that provide water-quality benefits or areas that are particularly susceptible to erosion and sediment loss;

2. Minimize impervious surfaces and break up or disconnect the flow of runoff over necessary impervious surfaces;

3. Maximize the protection of natural drainage features and vegetation;

4. Minimize the decrease in “time of concentration” from pre-construction to post-construction. “Time of concentration” is defined as the time it takes for runoff to travel from the hydraulically most distant point of the drainage area to the point of interest in the watershed (see the Rational Method equation in N.J.A.C. 5:21-7.2(c)2);

5. Minimize land disturbance, including clearing and grading;

6. Minimize soil compaction;

7. Provide low-maintenance landscaping that encourages retention and planting of native vegetation, and minimizes the use of lawns, fertilizers, and pesticides;

8. Provide vegetated open-channel conveyance systems discharging into and through stable vegetated areas; and

9. Provide preventative source controls to prevent or minimize the use or exposure of pollutants at a site so that the release of pollutants into stormwater runoff will be prevented or minimized. The source controls include, but are not limited to:

   i. Site design features that help to prevent accumulation of trash and debris in drainage systems;

   ii. Site design features that help to prevent discharge of trash and debris in the drainage system; and

   iii. When establishing vegetation after land disturbance, applying fertilizer in accordance with the *Standards for Soil Erosion and Sediment Control in New Jersey* at N.J.A.C. 2:90, as administered by the New Jersey Department of Agriculture.

(e) Any land area used as a nonstructural stormwater management measure to meet the performance standards for quantity control at N.J.A.C. 5:21-7.5, water quality at N.J.A.C. 5:21-7.6, or groundwater recharge at N.J.A.C. 5:21-7.7 shall be dedicated to a government agency, subject to a conservation restriction filed with the appropriate county clerk's office or equivalent restriction that ensures the stormwater measure, or an equivalent stormwater management measure approved by the reviewing agency, is maintained in perpetuity.

(f) Guidance for nonstructural stormwater management strategies is available in the *New Jersey Stormwater Best Management Practices Manual* (hereafter *Best Management Practices Manual*), April 2004 edition.

(g) All stormwater collection and conveyance structures shall be designed in accordance with the provisions of this subchapter. Any structures designed to control stormwater runoff volume, flow rate, quality, or groundwater recharge shall be designed and constructed in accordance with these provisions. Where more than one design or method may be used to comply with the rules, choices among design options to meet the volume, rate, quality, and recharge provisions of this subchapter shall rest with the design engineer.

(h) Construction practices shall conform to *Standards for Soil Erosion and Sediment Control in New Jersey,* N.J.A.C. 2:90.

(i) The standards of this subchapter do not apply to development if alternative design and performance standards exist under a regional stormwater management plan adopted in accordance with the New Jersey Department of Environmental Protection rules, N.J.A.C. 7:15. The standards must be at least as protective as those of this subchapter.

5:21-7.2 Stormwater Calculations: Runoff Estimation Techniques

(a) Drainage area stormwater management requires the determination of a watershed runoff hydrograph that displays the peak discharge rate and volume over time. The hydrograph shall compare pre- and post-development conditions. In computing pre-construction stormwater runoff, the design engineer shall account for all significant land features and structures such as ponds, wetlands, depressions, hedgerows, or culverts that may reduce pre-construction stormwater runoff rates and volumes. For the purpose of calculating runoff coefficients and groundwater recharge, there is a presumption that the

pre-construction condition of a site or portion thereof is a wooded land use with good hydrologic condition. The term "runoff coefficient" applies to both the Natural Resources Conservation Service (NRCS) of the United States Department of Agriculture (USDA) methodology of the TR-55 program (see (c)1.iii below), and the Rational and the Modified Rational Methods (see (c)1.i and (c)1.ii, respectively, below). Both the Rational and Modified Rational Methods are described in "Appendix A-9 -- Modified Rational Method" in the *Standards for Soil Erosion and Sediment Control in New Jersey* at N.J.A.C. 2:90. A runoff coefficient or a groundwater recharge land cover for an existing condition may be used on all or a portion of a site if the design engineer verifies that the hydrologic condition has existed on the site or portion of the site for at least five years without interruption immediately prior to the time of application. If more than one land cover has existed on the site during the five years immediately prior to the time of application, the land cover with the lowest runoff potential shall be used for the computations. In addition, there is the presumption that the site is in good hydrologic condition (if the land-use type if pasture, lawn, or park), with good cover (if the land-use type is woods), or with good hydrologic condition and conservation treatment (if the land use is cultivation).

(b) Design engineers shall use the runoff hydrograph peak rate to determine the configuration and sizes of pipes, channels, and other routing or flow-control structures. They shall use the hydrograph to determine the size of stormwater management facilities.

(c) For the runoff peak rate of discharge calculation, design engineers shall have the option to choose the methodology to estimate peak rate of discharge.

1. Design engineers shall calculate peak rate of runoff in accordance with the following procedures and methods, incorporated herein by reference:

   i. For relatively small drainage areas of up to one-half square mile (320 acres), the peak rate of runoff may be calculated by the Rational Method, its derivatives, or the referenced methods that follow.

   ii. Where the project necessitates reductions in the rate of runoff or the calculation of runoff volume in accordance with N.J.A.C. 5:21-7.5, the Modified Rational Method must be used. The use of the Modified Rational Method is limited to drainage areas of 20 acres or less.

   iii. NRCS's *Urban Hydrology for Small Watersheds, Technical Release No. 55 (TR-55)*.

   iv. NRCS's *Computer Program for Project Formulation -- Hydrology, Technical Release No. 20 (TR-20)*.

   v. *HEC-HMS Hydrologic Modeling System,* version 2.2, May 2003, Hydraulic Engineering Center, U.S. Army Corps of Engineers, used in appropriate conditions with appropriate values.

2. The equation for the Rational Method is:

   $$Q_p = C\ I\ A$$

   where

Q_p = the peak runoff rate in cubic feet per second

C = the runoff coefficient

I = the average rainfall intensity in inches per hour occurring at the time of concentration t_c

t_c = the time of concentration in minutes

A = the size of the drainage area in acres

i. Typical C values for 100-year frequency storm events appear in Table 7.1.

ii. The Rational Method is most accurate when dealing with uniform drainage areas. Design engineers may divide nonuniform drainage areas into "uniform" sub-drainage areas and calculate the runoff from each of these areas separately, or they may use the weighted average technique for a composite drainage area. Design engineers also may use runoff coefficients from the following sources, incorporated herein by reference:

(1) *HEC-22 – Urban Drainage Design Manual,* Second Edition, FHWA-NHI-01-021, August 2001, U.S. Department of Transportation, Federal Highway Administration, as supplemented or amended to date.

(2) New Jersey Department of Transportation (NJDOT) *Roadway Design Manual,* November 2001, as revised through March 28, 2003.

3. Design engineers may estimate time of concentration (t_c) with Figure 7.1, Time of Concentration nomograph, from *Roadway Design Manual,* NJDOT, November 2001, as revised through March 28, 2003. Use of this figure is limited to the design of storm sewer systems. For other purposes, design engineers shall use the procedures outlined in Chapter 3 of *Urban Hydrology for Small Watersheds, Technical Release No. 55 (TR-55)*, U.S. Department of Agriculture, NRCS.

4. *The National Engineering Handbook, Part 630 (Hydrology) and Part 650 (Engineering Field Handbook)* also may be used.

5. When using the Rational Method, rainfall intensity as a function of duration and storm frequency shall be based upon Figure 7.2, Rainfall Intensity Curves, and/or local rainfall frequency data, where available, for the 2-, 10-, 25-, and 100-year storms. Design engineers shall use the Cumulative and Incremental Rainfall Distributions in Table 7.3 for the water quality storm. Figure 7.2 shows rainfall intensity curves for Trenton, New Jersey. Design engineers may use this information for other parts of the State, or they may substitute local rainfall frequency data, when available. More current data for Trenton and other areas of the State may be obtained from the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service, which is part of the U.S.

Department of Commerce. See http://www.nws.noaa.gov/ohd/hdsc. In all instances, design engineers shall use a minimum time of concentration of ten minutes. For storm sewer design, a 10-year to 25-year storm frequency consistent with localized circumstances should be considered as a minimum, unless special circumstances are involved such as inadequate downstream stormwater facilities, lack of positive overland relief, or evidence of local flooding. In such special circumstances, design engineers shall design facilities to accommodate, as a minimum, the following storm frequencies:

i. Ten-year storm for storm drain systems where excess flow, up to the 100-year storm, can continue downgrade in the street and not exceed the gutter capacity. Also, 10-year storms shall be used at low points in storm drain systems with overland relief that is routed through the stormwater quantity control structure.

ii. Twenty-five-year storm where flow in a storm drain is totally carried by pipe when conditions under 5:21-7.2(c)5.i above do not apply, provided all overland relief up to the 100-year storm is routed through the stormwater quantity control structure.

iii. Twenty-five-year storm for culvert design where the culvert will be located in streams shown on the New Jersey State Atlas or the United States Coast and Geodetic Survey maps. Culverts with an upstream drainage area of 50 acres or more shall be designed to accommodate a 100-year frequency storm in accordance with Flood Hazard Area Control Regulations, N.J.A.C. 7:13-2.16.

iv. Twenty-five-year storms for open channels where the upstream drainage area is less than 50 acres. When the upstream drainage area is 50 acres or more, design engineers shall design open channels to accommodate the 100-year storm in accordance with Flood Hazard Area Control Regulations, N.J.A.C. 7:13-2.16.

6. The size of the drainage area shall include on-site and off-site lands contributing to the design point.

7. Computer software adaptations of the Rational Method or the NRCS's TR-55 are acceptable, provided their data and graphic printout allow review and evaluation.

(d) Design engineers shall use a consistent method to calculate peak rate of runoff and volume when computing runoff hydrographs. If TR-55, TR-20, HEC-HMS, or another recognized method is used to calculate peak rate of runoff, then the same method shall be used to determine volume. If the Rational Method is used for peak flow calculations, design engineers shall use the Modified Rational Method to calculate peak volume to be used for basin routing. Both the Rational and Modified Rational Methods are described in "Appendix A-9 – Modified Rational Method" in the *Standards for Soil Erosion and Sediment Control in New Jersey* at N.J.A.C. 2:90. A maximum drainage area of 20 acres shall be used for the Modified Rational Method.

(e) In computing stormwater runoff from all design storms, the design engineer shall consider the relative stormwater runoff rates and/or volumes from pervious and impervious surfaces separately to accurately compute the rates and volume of stormwater runoff from the site. To calculate runoff from unconnected impervious cover, urban impervious area modifications as described in NRCS TR-55, *Urban Hydrology for Small Watersheds*,

or other approved methods may be employed.

TABLE 7.1 TYPICAL RUNOFF COEFFICIENTS (C VALUES) FOR 100-YEAR FREQUENCY STORM

LAND-USE DESCRIPTION	HYDROLOGIC SOIL GROUP			
	A	B	C	D
Cultivated land:				
without conservation treatment	0.49	0.67	0.81	0.88
with conservation treatment	0.27	0.43	0.61	0.67
Pasture or range land:				
poor condition	0.38	0.63	0.78	0.84
good condition	NA	0.25	0.51	0.65
Meadow: good condition	NA	NA	0.44	0.61
Wood or forest land:				
thin stand, poor cover, no mulch	NA	NA	0.59	0.79
good cover	NA	NA	0.45	0.59
Open spaces, lawns, parks, golf courses, cemeteries:				
good condition, grass cover on 75% or more of area	NA	0.25	0.51	0.65
fair condition, grass cover on 50-75% of area	NA	0.45	0.63	0.74
Commercial and business areas (85% impervious)	0.84	0.90	0.93	0.96
Industrial districts (72% impervious)	0.67	0.81	0.88	0.92
Residential:				
Average lot size / Average impervious				
1/8 acre / 65%	0.59	0.76	0.86	0.90
1/4 acre / 38%	0.25	0.55	0.70	0.80
1/3 acre / 30%	NA	0.49	0.67	0.78
1/2 acre / 25%	NA	0.45	0.65	0.76
1 acre / 20%	NA	0.41	0.63	0.74
Paved parking lots, roofs, driveways, etc.	0.99	0.99	0.99	0.99
Streets and roads:				
paved with curbs and storm sewers	0.99	0.99	0.99	0.99
gravel	0.57	0.76	0.84	0.88
dirt	0.49	0.69	0.80	0.84

NOTE: NA denotes information is not available; design engineers should rely on another authoritative source.

SOURCE: *Technical Manual for Land Use Regulation Program,* Department of Environmental Protection, Bureaus of Inland and Coastal Regulations, Stream Encroachment Permits (Trenton, New Jersey, revised September 1995), p. 12.

Figure 7.1

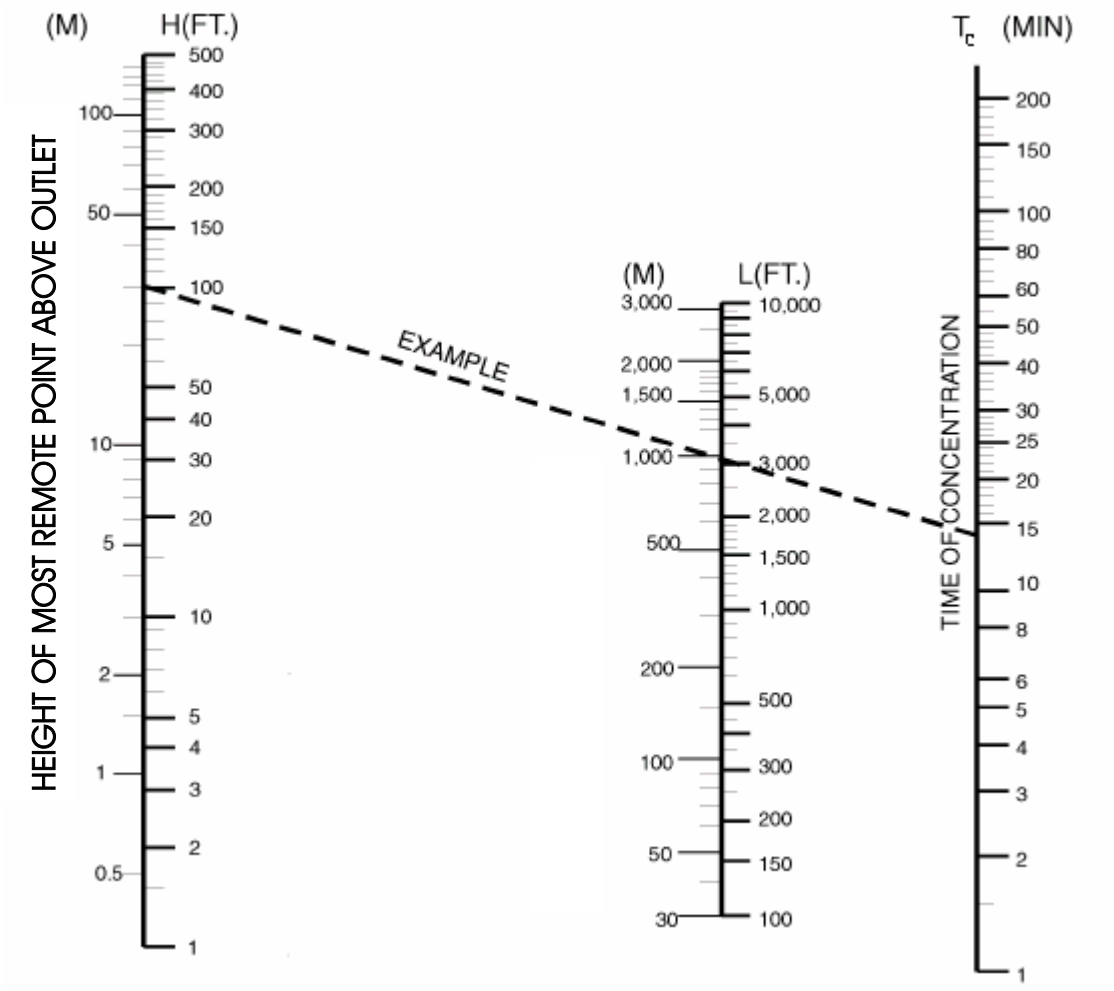
TIME OF CONCENTRATION

Example

Height = 100 ft.

Length = 3000 ft.

Time of Concentration = 14



Notes:

Use Nomograph T_c for natural basins with well-defined channels, for overland or bare earth, and for mowed grass roadside channels.

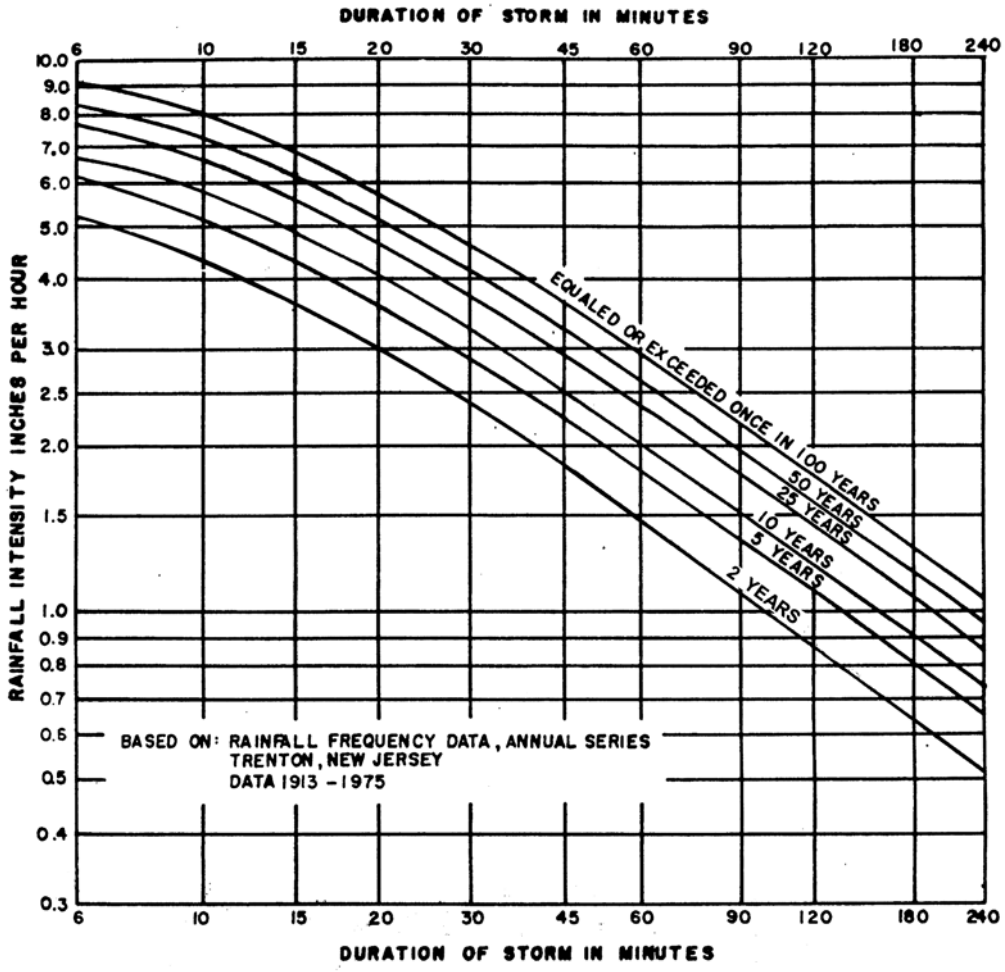
For overland flow, grassed surfaces, multiply T_c by 2.

For overland flow, concrete or asphalt surfaces, multiply T_c by 0.4.

For concrete channels, multiply T_c by 0.2 overland flow.

Based on a study by P.Z. Kirpich, *Civil Engineering*, Vol.10, No.6, June 1940, p. 362.

FIGURE 7.2 RAINFALL INTENSITY CURVES



Note: Adapted from Figure 2.1-2 in the NJDEP *Technical Manual for Stream Encroachment Permits*.

TABLE 7.2 MANNING'S ROUGHNESS COEFFICIENTS

CLOSED CONDUITS	SMOOTH	NORMAL	ROUGH
CAST IRON			
Coated	0.010	0.013	0.014
Uncoated	0.011	0.014	0.016
CLAY			
Vitrified sewer	0.011	0.014	0.017
Vitrified sewer with manholes	0.013	0.015	0.017
Common drainage tile	0.011	0.013	0.017
CONCRETE			
Culvert straight & free of debris	0.010	0.011	0.013
Culvert with bends, connections	0.011	0.013	0.014
Finished	0.011	0.012	0.014
Sewer with manhole inlets	0.013	0.015	0.017
Unfinished steel form	0.012	0.013	0.014
Unfinished smooth wood form	0.012	0.014	0.016
Unfinished rough wood form	0.015	0.017	0.020
METAL, CORRUGATED			
Sub-drain	0.017	0.019	0.021
Storm drain	0.021	0.024	0.030
POLYVINYL CHLORIDE (PVC)	0.010	0.010	0.010
POLYETHYLENE (PE)	0.008	0.009	0.011
STEEL			
Lockbar and welded	0.010	0.012	0.014
Riveted and spiral	0.013	0.016	0.017
WROUGHT IRON			
Black	0.012	0.014	0.015
Galvanized	0.013	0.016	0.017
LINED OR BUILT-UP CHANNELS	**MINIMUM**	**NORMAL**	**MAXIMUM**
ASPHALT			
Smooth	0.013	0.013	
Rough	0.016	0.016	
BRICK			
Glazed	0.011	0.013	0.015
In cement mortar	0.012	0.015	0.018
CEMENT			
Neat surface	0.010	0.011	0.013
Mortar	0.011	0.013	0.015
CONCRETE			
Trowel finish	0.011	0.013	0.015
Float finish	0.013	0.015	0.016
Finished with gravel on bottom	0.015	0.017	0.020
Unfinished	0.014	0.017	0.020
Gunite (good section)	0.016	0.019	0.023
Gunite (wavy section)	0.018	0.022	0.025
On good excavated rock	0.017	0.020	
On irregular excavated rock	0.022	0.027	

(continued on next page)

TABLE 7.2 continued. MANNING'S ROUGHNESS COEFFICIENTS

LINED OR BUILT-UP CHANNELS	MINIMUM	NORMAL	MAXIMUM
CONCRETE BOTTOM FLOAT FINISHED WITH SIDES OF			
Dressed stone in mortar	0.015	0.017	0.020
Random stone in mortar	0.017	0.020	0.024
Cement rubble masonry, plastered	0.016	0.020	0.024
Cement rubble masonry	0.020	0.025	0.030
Dry rubble or riprap	0.020	0.030	0.035
DRESSED ASHLAR	0.013	0.015	0.017
GRAVEL BOTTOM SIDES OF			
Formed concrete	0.017	0.020	0.025
Random stone in mortar	0.020	0.023	0.026
Dry rubble or riprap	0.023	0.033	0.036
MASONRY			
Cement rubble	0.017	0.025	0.030
Dry rubble	0.023	0.032	0.035
METAL, CORRUGATED	0.021	0.025	0.030
STEEL, SMOOTH SURFACE			
Unpainted	0.011	0.012	0.014
Painted	0.012	0.013	0.017
WOOD			
Planed, untreated	0.010	0.012	0.014
Planed, treated	0.011	0.012	0.015
Unplaned	0.011	0.013	0.015
Plank with battens	0.012	0.015	0.018
Lined with roofing	0.010	O.014	0.017
VEGETAL LINING	0.030		0.500
EXCAVATED, DREDGED, OR NATURAL CHANNELS	**MINIMUM**	**NORMAL**	**MAXIMUM**
CHANNELS NOT MAINTAINED AND BRUSH UNCUT			
Dense weeds, high flow depth	0.050	0.080	0.120
Clean bottom, brush on sides	0.040	0.050	0.080
Same, highest stage of flow	0.045	0.070	0.110
Dense brush, high stage	0.080	0.100	0.140
DRAG LINE -- EXCAVATED OR DREDGED			
No vegetation	0.025	0.028	0.033
Light brush or banks	0.035	0.050	0.060
EARTH, STRAIGHT AND UNIFORM			
Clean, recently completed	0.016	0.018	0.020
Clean, after weathering	0.018	0.022	0.025
Gravel, uniform section, clean	0.022	0.025	0.030
Short grass, few weeds	0.022	0.027	0.033
EARTH, WINDING AND SLUGGISH			
No vegetation	0.023	0.025	0.030
Grass, some weeds	0.025	0.030	0.033
Dense weeds or aquatic plants	0.030	0.035	0.040
Earth bottom and rubble sides	0.028	0.030	0.035
Stony bottom and weedy banks	0.025	0.035	0.040
Cobble bottoms and clean sides	0.030	0.040	0.050

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TABLE 7.2 continued. MANNING'S ROUGHNESS COEFFICIENTS			
EXCAVATED, DREDGED, OR NATURAL CHANNELS	**MINIMUM**	**NORMAL**	**MAXIMUM**
ROCK CUTS			
Smooth and uniform	0.025	0.035	0.040
Jagged and irregular	0.035	0.040	0.050
MINOR STREAMS (TOP WIDTH AT FLOOD STAGE <100 FT.)			
(a) Streams on plain			
1. Clean, straight, full stage, no rifts or deep pools	0.025	0.030	0.033
2. Same as above, but some stones and weeds	0.030	0.035	0.040
3. Clean, winding, some pools and shoals	0.033	0.040	0.045
4. Same as above, but some weeds and stones	0.035	0.045	0.050
5. Same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
6. Same as 4, but more stones	0.045	0.050	0.060
7. Sluggish reaches, weedy, deep pools	0.050	0.070	0.080
8. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.075	0.100	0.150
(b) Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages			
1. Bottom: gravels, cobbles, and few boulders	0.030	0.040	0.050
2. Bottom: cobbles with large boulders	0.040	0.050	0.070

TABLE 7.3 CUMULATIVE AND INCREMENTAL RAINFALL DISTRIBUTIONS FOR THE WATER QUALITY STORM

Time (minutes)	Cumulative Rainfall (inches)	Incremental Rainfall (inches)	Time (minutes)	Cumulative Rainfall (inches)	Incremental Rainfall (inches)
0	0.0000	0.0000	65	0.8917	0.2667
5	0.0083	0.0083	70	0.9917	0.1000
10	0.0166	0.0083	75	1.0500	0.0583
15	0.0250	0.0084	80	1.0840	0.0340
20	0.0500	0.0250	85	1.1170	0.0330
25	0.0750	0.0250	90	1.1500	0.0330
30	0.1000	0.0250	95	1.1750	0.0250
35	0.1330	0.0330	100	1.2000	0.0250
40	0.1660	0.0330	105	1.2250	0.0250
45	0.2000	0.0340	110	1.2334	0.0084
50	0.2583	0.0583	115	1.2417	0.0083
55	0.3583	0.1000	120	1.2500	0.0083
60	0.6250	0.2667			

5:21-7.3 Design of Runoff Collection Systems

(a) Design engineers shall determine hydraulic capacity for open-channel or closed-conduit flow based on the Manning equation, or charts/monographs based on this equation. The hydraulic capacity is termed "Q" and expressed as discharge in cubic feet per second as follows:

$$Q = (1.486/n)AR^{2/3}S^{1/2}$$

where

n = Manning's roughness coefficient

A = Cross-sectional area of flow in square feet

R = Hydraulic radius in feet, R = A/P, where P is equal to the wetted perimeter, measured in feet and defined as the length of a line of contact between the flowing water and the channel

S = Slope of energy grade line in feet per foot

The Mannings's roughness coefficients used by design engineers appear in N.J.A.C. 5:21-7.2, Table 7.2.

1. A direct application of Manning's equation may be used for piped storm sewer systems. As an option, design engineers can use a standard step backwater calculation for storm sewer systems if the use of this approach is deemed appropriate by the designer. For other than pipe storm sewer systems, design engineers shall apply Manning's equation only when there is uniform flow, as defined by the following conditions:

   i. The bottom slope of the channel, energy grade line, and water surface (hydraulic grade line) are parallel;

   ii. The flow regime is in the turbulent range of Reynolds number; and

   iii. The boundaries of the cross section of the channel do not move.

2. The design of open channels and conduits shall take tailwater effects into consideration.

(b) Velocities in open channels, excluding water quality swales, at design flow shall not be less than 0.5 of a foot per second and not greater than a velocity that will begin to cause erosion or scouring of the channel. Design engineers shall determine permissible velocities for swales, open channels, and ditches using methods presented in *Standards for Soil Erosion and Sediment Control in New Jersey* at N.J.A.C. 2:90.

(c) Velocities in closed conduits at design flow shall be at least two feet per second, but not more than the velocity that will cause erosion damage to the conduit, per the manufacturer's specifications. Minimum allowable pipe slopes shall produce velocity of at least three feet per second when the flow depth is full or half the pipe diameter.

(d) Design engineers shall base culvert capacity on inlet/outlet analysis, as specified in *Hydraulic Design of Highway Culverts, Hydraulic Design Series (HDS) No. 5*, Report No. FHWA-IP-85-15, U.S. Department of Transportation, Federal Highway Administration, September 1985, incorporated herein by reference.

(e) Design engineers shall determine pipe size based on design runoff, conduit entrance conditions, and hydraulic capacity.

(f) In general, no pipe size in the storm drainage system shall be less than 15 inches in diameter. Design engineers may use a 12-inch diameter pipe as a cross-drain to a single inlet.

(g) All discharge pipes shall terminate with an appropriate precast concrete or flared-end section or concrete headwall with or without wingwalls, as conditions require. Design engineers shall consider such site conditions as slope, soil stability, vegetation, grade, and size of conduit to determine whether or not to use wingwalls.

(h) Materials used in the construction of storm sewers shall be constructed of reinforced concrete, ductile iron, or corrugated polyethylene or, when approved by the municipal engineer, corrugated metal. The most cost-effective materials shall be permitted that conform to local site conditions and reflect the relevant operations, maintenance, and system character of the municipal stormwater system. Specifications referred to, such as ASTM or AWWA, shall be the latest revision in effect at the time of application.

1. The following apply to reinforced concrete pipe:

   i. Circular reinforced concrete pipe and fittings shall meet the requirements of ASTM C76.

   ii. Elliptical reinforced concrete pipe shall meet the requirements of ASTM C507.

   iii. Joint design and joint material for circular pipe shall conform to ASTM C443.

   iv. Joints for elliptical pipe shall be bell and spigot or tongue and grove sealed with butyl, rubber tape, rubber ring gaskets, or external sealing bands conforming to ASTM C877.

   v. All pipe shall be Class III minimum unless loading conditions call for stronger pipe (i.e., higher class).

   vi. The minimum depth of cover over the concrete pipe shall be as designated by the American Concrete Pipe Association in Table 7.4.

   vii. Minimum depth of cover standards for ductile iron and corrugated polyethylene pipe shall conform to manufacturer standards.

2. Ductile iron pipe shall conform to ANSI/AWWA C151/A21.51. Joints shall conform to ANSI/AWWA C111/A21.11 or ANSI/AWWA C115/A21.15, as appropriate. Pipe shall be designed in accordance with ANSI/AWWA C150/A21.50. The outside of the pipe shall be coated in accordance with ANSI/AWWA C151/A21.51 and the inside lined in accordance with ANSI/AWWA C104/A21.4. Ductile iron pipe shall be installed in accordance with AWWA C600.

TABLE 7.4 MINIMUM DEPTH OF COVERAGE OVER CONCRETE PIPE

PIPE DIAMETER (in inches)	ASTM CLASS PIPE	MINIMUM COVER (surface to top of pipe in inches)
12	III IV V	17 12 7
15	III IV V	16 11 7
18	III IV V	16 10 6
24	III IV V	15 6 6
30	III IV V	10 6 6
36 & above	III IV	6 6

Minimum cover as designated by the American Concrete Pipe Association.

3. Corrugated polyethylene pipe shall conform to AASHTO M252 for three through 10 inches and AASHTO M294 for sizes 12 inches and larger. All pipes greater than 12 inches in diameter shall be Type S, unless conditions dictate otherwise. Materials shall conform to ASTM D3350, *Standard Specification for Polyethylene Plastics Pipe and Fittings Materials*. Pipe joints and fittings shall be compatible with the pipe material and shall conform to the same standards and specifications as the pipe material. Pipe couplers shall not cover less than one full corrugation on each section of pipe. Installation shall be in accordance with ASTM D2321, *Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications*. Backfill material shall be placed in six-inch lifts and compacted to 95 percent minimum dry density, per AASHTO T99. In areas of high ground water tables, design engineers shall check for flotation.

4. Corrugated metal pipe, when approved by the municipal engineer, shall meet the requirements and be installed in the manner specified in Appendix A of this subchapter.

(i) Pipe bedding and backfill shall be provided as specified in *Design and Construction of Urban Stormwater Management Systems*, ASCE Manuals and Reports of Engineering Practice No. 77, 1993, incorporated herein by reference. Bedding and backfill for any pipe material not covered by this manual shall be installed in accordance with manufacturer's recommendations. The municipal engineer may require the developer to provide professional certification as to the suitability of backfill material and where such suitability does not exist, any modifications needed to use on-site material and the

appropriate methods to install this material. The municipal and/or utility engineer shall rely on this certification.

(j) No pipe shall be placed on private property unless the owner of the land is to own or operate the pipe, or an easement deeded to the municipality is obtained. All easements shall be a minimum of 20 feet wide unless depth of pipe, soil conditions, or additional utilities require wider. Where the easement is located adjacent to a right-of-way, the municipality may approve a narrower easement.

5:21-7.4 Inlets, Catch Basins, Manholes, and Outlets

(a) Design engineers shall design inlets, catch basins, and manholes in accordance with the NJDOT *Standard Specifications for Road and Bridge Construction*, November 2001, as supplemented. For Type A inlets, they should use a frame and single grate. Type B inlets require a frame, grate, and curb-type inlet with back piece. Type E inlets require a frame and double grate.

(b) Design engineers shall use one of the following grate types for stormwater inlets:

1. The NJDOT bicycle-safe grate, as described in the NJDOT *Bicycle Compatible Roadways and Bikeways Planning Design Guidelines* (April 1996).

2. If there is no bicycle traffic, a grate where each individual clear space in that grate has an area of no more than 7 square inches or is no greater than 0.5 inches across the smallest dimension.

3. Another grate design may be used, provided that:

i. There will be no bicycle traffic and

ii. Runoff discharging through the inlet is routed through a trash rack that complies with N.J.A.C. 5:21-7.8(d)1.ii.

(c) Whenever a curb-opening inlet is used, the clear space in that curb opening (or each individual clear space if the curb opening has two or more clear spaces) shall have an area of no more than seven square inches, or be no greater than two inches across the smallest dimension.

1. Exception: Compliance with the above dimensional requirements for curb openings shall not be required provided that runoff discharging through the inlet is routed through a trash rack that complies with N.J.A.C. 5:21-7.8(d)1.ii.

(d) Inlet spacing depends on the inlet capacity. Maximum gutter line flow is 400 feet. The maximum capacity of a curb inlet shall be 6 cubic feet per second. Area inlets in parking lots should be limited to 3 cubic feet per second.

(e) Manholes shall be precast concrete or concrete block coated with two coats of portland cement mortar outside the manhole. Masonry brick may be used to make vertical adjustments to rims, as long as the adjustments are 12 inches or less. In acidic soils, all manholes shall have two coats of black bitumastic waterproofing applied per manufacturer's instruction.

(f) If precast manhole barrels and cones are used, they shall conform to ASTM Specification C478, with round rubber gasketed joints conforming to ASTM Specification C923. Both ASTM specifications are incorporated herein by reference. Maximum absorption shall be 8 percent in accordance with ASTM Specification C478, Method A.

(g) If precast manholes are used, the top riser section shall terminate less than one foot below the finished grade and the manhole cover shall be flush with the finished grade.

(h) Manhole frames and covers shall be of cast iron, conforming to ASTM Specification A48, Class 30, incorporated herein by reference, and be suitable for H-20 loading capacity. Manhole covers in remote locations may have a locking device.

(i) Outlet grates, fences, and other safety features for stormwater management facilities shall conform with DEP Stormwater Management Rules, N.J.A.C. 7:8. Safety requirements for detention basins and other stormwater facilities are incorporated in N.J.A.C. 5:21-7.8(d)6.

(j) The channel should be, insofar as possible, a smooth continuation of the pipe. The pipe may be laid through the manhole and the top half removed by saw cut. The completed channel should be U-shaped. The channel height shall be three-fourths of the diameter of the pipe.

(k) The bench should provide good footing for a workman, and a place where minor tools and equipment can be laid. It must have a slope of four to eight percent.

5:21-7.5 Stormwater Management: Quantity Control

The control of the quantity of runoff shall comply with the DEP Stormwater Management Rules at N.J.A.C 7:8-5 and 6 reprinted in Appendix B of this subchapter.

5:21-7.6 Stormwater Management: Water Quality

Water quality for stormwater management systems, including special water resource protection areas for Category One Waters and their perennial or intermittent tributaries, shall comply with the DEP Stormwater Management Rules at N.J.A.C. 7:8-5 and 6, reprinted in Appendix B of this subchapter.

5:21-7.7 Recharge

Groundwater recharge of stormwater shall be in accordance with the DEP Stormwater Management Rules at N.J. A.C. 7:8-5 and 6, reprinted in Appendix B of this subchapter.

5:21-7.8 Detention Basins and Other Stormwater Management Facilities

(a) When structural measures are used, they shall comply with the requirements of these rules and the Best Management Practices Manual, April 2004 edition.

(b) Design engineers shall locate detention facilities (either "wet" or "dry") so as to not interfere with or adversely affect existing surface waters on the site or adjacent to the site. Excavation for detention facilities shall be designed to be the maximum practical

distance above seasonal high ground water elevation. In the case of "wet" detention facilities, storage may only be presumed to be available above the elevation of the seasonal high ground water. If the facility is designed as an infiltration basin, the bottom of the basin shall be a minimum of two feet above the elevation of the seasonal high water table. The determination of the seasonal high water table shall be made by the applicant's engineer.

(c) Design of outlets from detention basins and other stormwater management facilities shall account for tailwater effects up to the flood hazard design flood elevation.

(d) The following list of general structural criteria shall be used to design stormwater detention basins.

1. Detention components: principal basin control structure (quantity control), as follows:

i. Principal basin control structures will consist of orifice and/or weir control devices. Design engineers shall design orifices based upon the following equation:

$$Q = C\,A\,(2gH)^{0.5}$$

where

Q = The flow rate in cubic feet per second

C = 0.6 (The orifice flow coefficient "C" may vary, depending on entrance conditions. Design engineers may use other coefficients with appropriate references.)

A = Cross-sectional area of flow in square feet

H = The vertical distance in feet between the center of the orifice and the water surface

2g = 64.4 feet per second^2

To minimize the chance of clogging, orifices intended solely for runoff quantity control will be at least two and one-half inches in diameter (or its equivalent). All joints are to be watertight. In addition, trash racks and/or anti-vortex devices shall be required. When weirs are used alone or in conjunction with orifices, design engineers shall use the following equation:

$$Q = C_wL(h)^{3/2}$$

where

Q = The flow rate in cubic feet per second

C_w = 3.2 (Design engineers may use other coefficients with appropriate references.)

L = Length of the weir in feet

h = The vertical distance in feet between water surface elevation and the crest of the weir

All weirs shall be constructed as part of a reinforced concrete structure with appropriate grates.

ii. Trash racks and/or anti-vortex devices shall be installed at the intake to the outlet structure as appropriate, and shall have parallel bars with one-inch spacing between bars to the elevation of the water quality design storm. For elevations higher than the water quality design storm, the parallel bars at the outlet structure shall be spaced no greater than one-third the width of the diameter of the orifice or one-third the width of the weir, with a minimum spacing between bars of one inch and a maximum spacing between bars of six inches. The spacing shall be designed so as not to adversely affect the hydraulic performance of the outlet pipe or structure. In addition, the design of trash racks shall comply with the requirements of (d)6 below.

iii. Eight-inch thick, anti-seep collars are to be installed along outlet pipes when required by the municipal engineer. Reinforcement steel shall be No. 5 bars at 12 inches both ways, with two inches of cover on both faces (minimum).

iv. Where necessary for stability of the outlet pipe, a concrete cradle shall be provided.

v. All principal basin control structures shall be precast or reinforced concrete. All joints are to be watertight.

vi. Suitable lining shall be placed upstream and downstream of principal basin control structures, as necessary, to prevent scour and erosion. Such lining shall conform to *Standards for Soil Erosion and Sediment Control in New Jersey*, N.J.A.C. 2:90.

2. Detention components: emergency spillways, as follows:

i. Vegetated emergency spillways shall have side slopes not exceeding three horizontal to one vertical.

ii. Maximum velocities in emergency spillways shall be checked based on the velocity of the peak flow in the spillway resulting from routing the spillway design storm hydrograph as defined in the NJ DEP Dam Safety Rules (N.J.A.C. 7:20) for all detention facilities classified as dams and the 100-year storm hydrograph for all other facilities (the routed Emergency Spillway Hydrograph). The design of the emergency spillway will be based on the 100-year inflow to the basin except for Class IV dams, which shall comply with the Dam Safety Standards, N.J.A.C. 7:20. The design of the emergency spillway assumes the principal spillway is malfunctioning and will not allow any discharge or flow. Where maximum velocities exceed those contained in Table 7.5, suitable lining shall be provided.

iii. Where maximum velocities exceed the allowable velocities for soil stability as determined in the *Standards for Soil Erosion and Sediment*

Control in New Jersey, N.J.A.C. 2:90, suitable lining should be provided. Design engineers also may check maximum velocities in emergency spillways based on the velocity of the peak flow in the spillway resulting from routing the spillway design storm hydrograph as defined in the NJ DEP Dam Safety Rules (N.J.A.C. 7:20) for all detention facilities classified as dams and the 100-year storm hydrograph for all other facilities. Where maximum velocities exceed those contained in Table 7.5, suitable lining shall be provided. Linings shall meet specifications required in *Hydraulic Engineering Circular No. 15 -- Design of Stable Channels with Flexible Linings*, published by the U.S. Department of Transportation, Federal Highway Administration or in the *Standards for Soil Erosion and Sediment Control in New Jersey* as cited above.

TABLE 7.5 PERMISSIBLE VELOCITIES FOR EMERGENCY SPILLWAYS WITH UNIFORM STANDS FOR VARIOUS WELL-MAINTAINED GRASS COVERS

Ground Cover	Slope Percent	Permissible Velocities On:	
		Erosion-Resistant Soils (fps)	Easily Eroded Soils (fps)
Kentucky bluegrass	5-10	6	4
Lawn grass mixture	0-5 5-10	5 4	4 3
Weeping lovegrass Alfalfa Crabgrass	0-5	3.5	2.5

NOTES: fps = feet per second.

Designs are not limited to the ground covers shown above. Design engineers may use reinforced grass technologies and other types of ground cover in accordance with appropriate authoritative standards.

SOURCE: Soil Conservation Service, U.S. Department of Agriculture (Washington, D.C.: Government Printing Office, 1959). Cited in *Residential Storm Water Management: Objectives, Principles, and Design Considerations*, ULI-ASCE-NAHB, Urban Land Institute (Washington, D.C.: 1975).

3. Detention components: dams, as follows:

i. "Dam" refers to any artificial dike, levee, or other barrier with appurtenant works that is constructed to impound water on a permanent or temporary basis and raises the water level five feet or more above the usual, mean, low-water height when measured from the downstream toe-of-dam to the emergency spillway crest or, in the absence of an emergency spillway, the top of the dam.

ii. Design engineers shall design all dams in accordance with the Dam Safety Standards, N.J.A.C. 7:20.

4. Detention basin berms and embankment ponds, as follows:

i. A detention basin berm is a water impoundment made by either constructing an embankment (a facility referred to as an embankment pond), or excavating a pit or dugout that does not qualify as a dam. Detention basin berms constructed by the second method are referred to as excavated ponds.

ii. Site conditions shall be such that runoff from the design storm can safely pass through: a natural or constructed emergency spillway designed to accept the entire 100-year flow; a combination of a principal spillway and the emergency spillway designed to ensure passage of the 100-year flow when either the principal spillway and/or the emergency spillway flows are impeded by debris; or a principal spillway designed so as to allow it to continue to function reliably, passing the 100-year flow, when impeded by debris.

(1) The drainage area of the pond shall be protected against erosion so that expected sediment does not shorten the planned effectiveness of the structure.

(2) When necessary, embankment ponds shall have foundation cutoff walls of relatively impervious material under the berm. The cutoff walls shall extend up to abutments as required and be deep enough to extend into a relatively impervious layer, or provide for a stable structure when combined with seepage control. The cutoff trench shall have a bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations. Cutoff wall side slopes shall not be steeper than one horizontal to one vertical. The cutoff walls shall extend up to the normal water line and the minimum depth shall be at least three feet.

(3) Design engineers shall include seepage controls if any of the following conditions exist: pervious layers are not intercepted by the cutoff wall, seepage creates swamping downstream, such control is needed to insure a stable embankment, or special problems may require drainage for a stable berm. Seepage may be controlled by foundation, abutment, or embankment drains; reservoir blanketing; or a combination of these measures.

(4) The minimum top width for a berm shall be six feet. The minimum top width of dams should be ten feet.

(5) All slopes must be designed to be stable. If needed to protect the slopes of the berm, special measures such as rock riprap, sand gravel, fabrics, geofabrics, geomembranes, or special vegetation shall be provided, as specified by the standards in: *Guide for Design and Layout of Vegetative Wave Protection for Earth Dam Embankments, TR-56*, and *Riprap for Slope Protection Against Wave Action, TR-69*. Both reports are published by the NRCS and are incorporated herein by reference.

(6) The minimum elevation of the top of the settled embankment shall be one foot above the water surface in the detention basin, with the emergency spillway flowing at the design depth. The minimum difference in elevation between the crest of the emergency spillway and the settled top width of the structure shall be two feet for all berms having more than a 20-acre drainage area or more than 20 feet in effective height. Design engineers shall increase the design height of the structure by the amount needed to insure that, after settlement, the height of the berms equals or exceeds the design height. This increase shall not be less than five percent, except where detailed soil testing and laboratory analysis show that a lesser amount is adequate.

(7) Design engineers shall place a pipe conduit with needed appurtenances under or through the berm except where rock, concrete, or other types of mechanical spillways are used, or where the rate and duration of flow can be safely handled by a vegetated or earth spillway.

iii. The design elevation of the top of all embankments and berms shall be one foot or greater than the maximum water surface elevation in the basin, when stormwater from the 100-year flood passes over the emergency spillway. The design height, defined as the vertical distance from the top to the bottom of the deepest cut, shall be constructed to insure that the top elevation will be maintained following all settlement.

(1) When the design discharge of the principal spillway is considered in calculating peak outflow through the emergency spillway, the crest elevation of the inlet shall be such that the full flow will be generated in the conduit before there is discharge through the emergency spillway. The inlets and outlets of the principal spillway shall be designed to function satisfactorily for the full range of flow and hydraulic head anticipated. The capacity of the pipe conduit shall be adequate to discharge long-duration, continuous, or frequent flows without flow through the emergency spillways. The pipe diameter shall be no less than six inches. If the pipe conduit diameter is larger than ten inches, its design discharge may be considered when calculating the peak outflow rate through the emergency spillway.

(2) Pipe conduits under or through the berm shall be capable of withstanding external loading without yielding, buckling, or cracking. Flexible pipe strength shall not be less than that necessary to support the design load with the maximum of five percent deflection. The inlets and outlets shall be structurally sound, and made of materials compatible with those of pipe. All pipe joints shall be made watertight by the use of couplings, gaskets, or caulking.

iv. In earthen berms and embankment ponds, acceptable pipe materials are corrugated polyethylene, reinforced concrete, polyvinyl chloride, and ductile iron. When necessary for stability, concrete and ductile pipe shall be laid in a concrete bedding. Corrugated polyethylene pipe exposed to direct sunlight shall be made of ultraviolet-resistant materials and

protected by coating or shielding, or provisions for replacement should be made as necessary. Connections of corrugated polyethylene pipe to less flexible pipe or structure must be designed to avoid stress concentrations that could rupture the plastic. Design engineers shall follow specifications in Table 7.6 for polyvinyl chloride (PVC) pipe. Design engineers shall provide for seepage control if the conduit is of smooth pipe larger than eight inches in diameter.

TABLE 7.6 ACCEPTABLE PVC PIPE FOR USE IN EARTH BERMS[†]

NORMAL PIPE SIZE (inches)	SCHEDULE FOR STANDARD DIMENSION RATIO (SDR)	MAXIMUM DEPTH OF FILL OVER PIPE (feet)
4 or smaller	Schedule 40	15
	Schedule 80	20
	SDR 26	10
6, 8, 10, 12	Schedule 40	10
	Schedule 80	15
	SDR 26	10

[†]Polyvinyl chloride pipe, PVC 1120 or PVC 1220, conforming to ASTM D1785 or ASTM D2241.

v. Seepage along pipes extending through embankments shall be controlled by use of a filter and drainage diaphragm, unless it is determined that anti-seep collars will adequately serve the purpose.

(1) The drain is to consist of sand meeting fine concrete aggregate requirements (at least 15 percent passing through the No. 40 sieve, but no more than 10 percent passing through the No. 100 sieve). If unusual soil conditions exist, design engineers shall make a special design analysis. The drain shall be a minimum of two feet thick, and extend vertically upward and horizontally at least three times the pipe diameter, and vertically downward at least 18 inches beneath the conduit invert. The drain diaphragm shall be located approximately parallel to the centerline of the embankment. The drain shall be outletted at the embankment downstream toe, preferably using a drain backfill envelope continuously along the pipe where it exits in the embankment. Protecting drain fill from the surface erosion will be necessary.

(2) When anti-seep collars are used in lieu of a drainage diaphragm, they shall have a watertight connection to the pipe. Maximum spacing shall be approximately 14 times the minimum projection of the collar measured perpendicular to the pipe. Collar material shall be compatible with the pipe materials. The anti-seep collar(s) shall increase by 15 percent the seepage path along the pipe. When anti-seep collars are used in lieu of a drainage

diaphragm, the design engineers shall use the following criteria to determine the size and number of anti-seep collars.

Let V = Vertical projection and minimum horizontal projection of the anti-seep collar in feet.

Let L = Length in feet of the conduit within the zone of saturation, measured from the downstream side of the riser to the toe drain or point where the phreatic line intercepts the conduit, whichever is shorter.

Let n = Number of anti-seep collars.

The ratio (L+2nV)/L shall be at least 1.15. Anti-seep collars should be equally spaced along part of the barrel within the saturated zone at distances of not more than 25 feet.

vi. Closed-circuit spillways designed for pressure flow must have adequate anti-vortex devices. To prevent clogging of the conduit, an appropriate trash guard shall be installed at the inlet or riser.

vii. Emergency spillways convey the design flow safely past earth embankments when the principal or auxiliary spillway is disabled. Design engineers shall provide for an emergency spillway for each basin.

(1) Emergency spillways shall provide for passage of the design flow at a safe velocity to a point downstream where the berm will not be endangered. The maximum permissible velocity in the exit channel shall be four feet per second, where only sparse vegetative cover can be expected; where excellent vegetative cover and a vigorous sod can be expected and maintained, the maximum permissible velocity is six feet per second.

(2) If chutes or drops are used for the principal or emergency spillways, they shall be designed according to standards in NRCS's Part 650 (*Engineering Field Handbook*) and *National Engineering Handbook*, Part 630 (Hydrology), Section 5, "Hydraulics;" Section 11, "Drop Spillways;" and Section 14, "Chute Spillways," incorporated herein by reference. The minimum capacity of a structural spillway shall be that required to pass the peak flow expected from the design storm.

viii. For excavated basins, provisions shall be made where needed for a principal spillway, emergency spillway, and embankment in accordance with the embankment and berm criteria described in this section.

(1) Where soil conditions and safe maintenance practices allow, side slopes of the excavated basin shall be stable and no steeper than three horizontal to one vertical.

ix. The material placed in the fill shall be free of detrimental amounts of sod, roots, frozen soil, stones more than six inches in diameter (except rock fills), and other objectionable material.

(1) Drain fill shall be kept from being contaminated by adjacent soil materials during placement by either placing it in a cleanly excavated trench, or by keeping the drain at least one foot above the adjacent earth fill.

(2) Selected drain fill and backfill material shall be placed around structures, pipe conduits, and anti-seep collars at about the same rate on all sides to prevent damage from unequal loading. Fill material shall be placed and spread beginning at the lowest point in the foundation, and then bringing it up in continuous horizontal layers thick enough that the required compaction can be obtained. The fill shall be constructed in continuous horizontal layers. If openings or sectionalized fills are required, the slope of the bonding surfaces between the embankment in place and the embankment to be placed shall not be steeper than the ratio of three horizontal to one vertical. The bonding surface shall be treated the same as that specified for the foundation to insure a good bond with the new fill.

(3) The distribution and gradation of materials shall be such that no lenses, pockets, streaks, or layers of material shall differ substantially in texture or gradation from the surrounding material. If it is necessary to use materials of varying texture and gradation, the more impervious material shall be placed in the center and upstream parts of the fill. If zoned fills of substantially differing materials are specified, the zones shall be placed according to lines and grades shown on the drawings. The complete work shall conform to the lines, grades, and elevations shown in the drawings or as staked in the field.

(4) The moisture content of the fill material shall be adequate for obtaining the required compaction. Material that is too wet shall be dried to meet this requirement, and material that is too dry shall be wetted and mixed until the requirement is met. Construction equipment shall be operated over each layer of fill to insure that the required compaction is obtained. Special equipment shall be used if needed to obtain the required compaction. If a minimum required density is specified, each layer of fill shall be compacted as necessary to obtain that density.

(5) Fill adjacent to structures, pipe conduits, and drain fill or anti-seep collars shall be compacted to a density equivalent to that of the surrounding fill by hand tamping, or by using manually directed power tampers or plate vibrators. Fill adjacent to concrete structures shall not be compacted until the concrete has had time to gain enough strength to support the load.

x. All permanent and temporary stabilization should be applied pursuant to the *Standards for Soil Erosion and Sediment Control in New Jersey*, at N.J.A.C. 2:90.

xi. In a principal spillway, pipe materials shall conform to the appropriate specifications. Anti-seep collars shall be made of materials compatible

with that of the pipe and shall be installed according to the manufacturer's instructions. It may be firmly and uniformly bedded throughout its length, and shall be installed to the line and grade shown on the drawings.

xii. The mix, design, and testing of concrete shall be consistent with the size requirements of the job. Mix requirements or necessary strength shall be specified. The type of cement, air entrainment, slump, aggregate, or other properties shall be specified as necessary. All concrete is to consist of a workable mix that can be placed and finished in an acceptable manner. Necessary curing shall be specified. Reinforcing steel shall be placed as indicated on the plans and shall be held securely in place during concrete placement. Subgrades and forms shall be installed to line and grade, and the forms shall be mortar tight and unyielding as the concrete is placed.

xiii. Foundation and embankment drains, if required, shall be placed to the line and grade shown on the drawings. Detailed requirements for drain material and any required pipe shall be shown in the drawings and specifications for the job.

xiv. Concerning excavated basins, the compacted excavation shall conform to the lines, grades, and elevations shown on the drawings or as staked in the field.

xv. Concerning embankment and excavated berms, construction operations shall be carried out so that erosion and air and water pollution are minimized, and held within legal limits. All work shall be conducted in a skillful manner. The completed job shall present a workmanlike appearance.

(1) Measures and construction methods that enhance fish and wildlife values shall be incorporated as needed and practical. Ground cover to control erosion shall be established as needed and practical. Fencing shall be provided as needed.

5. Detention facilities in flood hazard areas, as follows:

i. Detention development must comply with all applicable regulations under the Flood Hazard Area Control Act, N.J.S.A. 58:16A-50 et seq.

6. The following safety provisions shall apply to stormwater management basins and parts thereof.

i. Trash racks shall be installed at the intake to the outlet from the stormwater management basin to ensure proper functioning of the basin outlets.

ii. Bar spacing for trash racks shall be in accordance with (d)1.ii above.

iii. The average velocity of flow through a clean trash rack is not to exceed 2.5 feet per second under the full range of stage and discharge. Velocity is to be computed on the basis of the net area of opening through the rack.

iv. Any outlet structure with an overflow grate must have the grate secured but removable for emergencies and maintenance. Grate spacing shall be no greater than two inches across the smallest dimension.

v. Trash racks and overflow grates shall be constructed and installed to be rigid, durable, and corrosion resistant, and shall be designed to withstand a perpendicular live loading of 300 pounds per square foot.

vi. Every outlet structure of a basin shall have escape provisions in or on the structure. Escape provisions include the installation of permanent ladders, steps, rungs, or other features that provide easily accessible means of egress from the stormwater management basin. Free-standing outlet structures may be excluded at the discretion of the approving authority.

vii. Safety ledges shall be constructed on the slopes of all new retention basins, with a permanent pool of water deeper than 2½ feet. Ledges shall be comprised of two steps, each four to six feet in width, one located approximately 2½ feet below the permanent water surface and the second located 1 to 1½ feet above the permanent water surface.

viii. In new stormwater management basins, maximum interior slopes for earthen dams, embankments, or berms shall not exceed three horizontal to one vertical.

(e) Guidelines for the following stormwater management practices are found in the *Best Management Practices Manual*, April 2004 edition.

1. Bioretention systems;
2. Constructed stormwater wetlands;
3. Dry wells;
4. Extended detention basins;
5. Infiltration structures;
6. Manufactured treatment devices;
7. Pervious pavement;
8. Sand filters;
9. Vegetative filters; and
10. Wet ponds.

5:21-7.9 Maintenance Requirements

The maintenance of stormwater management measures shall comply with the DEP Stormwater Management Rules, N.J.A.C. 7:8-5 and 6, reprinted in Appendix B of this subchapter.

APPENDIX A TO SUBCHAPTER 7

CORRUGATED METAL PIPE

Corrugated metal pipe, when approved by the municipal engineer, shall meet the requirements and be installed in the following manner. Corrugated metal pipe for drainage structures is allowed in accordance with the attached map. In areas with acid waters (shaded area on the map), design engineers may use aluminum alloy, provided the environmental limitations below are met. In neutral/alkaline waters (unshaded on the map), aluminum, aluminum-coated steel type 2, and polymeric-coated steel may be used, provided the environmental limitations below are met. Water pH and resistivity values must fall within the ranges shown below. Samples should be measured in accordance with ASTM G51 and G57. Avoid sampling water during storm events or for two days following a storm to insure more typical readings. If there are severe corrosive conditions (pH < 4), fiber-bonded steel pipe should be used.

ENVIRONMENTAL LIMITS FOR CORRUGATED METAL PIPE		
Pipe Type	**pH**	**Resistivity Values (ohm-cm)**
Aluminum	4-9	>500
Aluminum-coated type 2	5-9	>1500
Polymeric coated	5-9	>1500
Fiber bonded	<4	-

If the design velocity is greater than 10 feet per second, a one-half bituminous coating and paved invert in accordance with ASTM A849 (AASHTO M190) is required.

Minimum depth of coverage shall be as follows:

MINIMUM DEPTH OF COVERAGE FOR CORRUGATED METAL PIPE	
Pipe Diameter (inches)	**Minimum Cover (inches) from Top of Pipe to Bottom of Flexible Pavement or Top of Rigid Pavement**
12 inches to 48 inches	12 inches
54 inches or more	Per manufacturer's recommendations

Corrugated aluminum pipe shall conform to the requirements of ASTM B745 (AASHTO M196) for types I, II, IR, IIR, and III.

Corrugated, aluminum-coated, steel type 2 pipe shall conform to the requirements of ASTM A760 (AASHTO M36) for types I, II, IR, IIR, and III and have an aluminum one-ounce type 2 coating as specified in ASTM A929 (AASHTO M274).

Corrugated, polymeric-coated steel pipe shall conform to the requirements of ASTM A762 (AASHTO M36) for types I and II, and have a polymeric 10/10 coating as specified in ASTM A742 (AASHTO M246).

Corrugated, fiber-bonded steel pipe shall conform to the requirements of ASTM A760 (AASHTO M36) for types I and II, and have an aramid fiber composite coating as specified in ASTM A885. In addition, the pipe shall be bituminous coated, as specified in ASTM A849 (AASHTO M190).

Corrugated metal pipe shall be fabricated with annular corrugations by riveted lap joint construction, or with helical corrugations and a continuous weld or lock seam extending from end to end of each length of pipe.

Connecting bands shall be manufactured in accordance with ASTM A760 (steel) or B745 (aluminum), and have the same base metal and coating as the corrugated metal pipe. All pipe ends shall be annularly reformed a minimum of two corrugations.

Fittings and end sections shall be of the same base metal and coating as the corrugated metal pipe.

Corrugated metal pipe shall be installed per ASTM A798 (steel) or ASTM B788.

Maximum cover and structural design of corrugated metal pipe shall be per ASTM A796 (steel) or ASTM B790.

APPENDIX B TO SUBCHAPTER 7
DEP Stormwater Management Rules
Referenced in N.J.A.C. 5:21-7:
N.J.A.C. 7:8-5 and 6, and Other
Relevant Portions of the Stormwater Rules

Definitions of words and terms used in N.J.A.C. 7:8-5 and 6:

"CAFRA Planning Map" means the geographic depiction of the boundaries for Coastal Planning Areas, CAFRA Centers, CAFRA Cores, and CAFRA Nodes, pursuant to N.J.A.C. 7:7E-5B.3.

"CAFRA Centers, Cores, or Nodes" means those areas within boundaries accepted by the Department, pursuant to N.J.A.C. 7:8E-5B.

"Compaction" means the increase in soil bulk density.

"Core" means a pedestrian-oriented area of commercial and civic uses serving the surrounding municipality, generally including housing and access to public transportation.

"Department" means the Department of Environmental Protection.

"Designated Center" means a State Development and Redevelopment Plan Center as designated by the State Planning Commission such as urban, regional, town, village, or hamlet.

"Design engineer" means a person professionally qualified and duly licensed in New Jersey to perform engineering services that may include, but not necessarily be limited to, development of project requirements, creation and development of project design, and preparation of drawings and specifications.

"Development" means the division of a parcel of land into two or more parcels; the construction, reconstruction, conversion, structural alteration, relocation, or enlargement of any building or structure; any mining excavation or landfill; and any use or change in the use of any building or other structure, or land or extension of use of land, for which permission is required under the Municipal Land Use Law, N.J.S.A. 40:55D-1 et seq. In the case of development on agricultural land, development means any activity that requires a State permit; any activity reviewed by the County Agricultural Boards (CAB) and the State Agricultural Development Committee (SADC); and municipal review of any activity not exempted by the Right to Farm Act, N.J.S.A. 4:1C-1 et seq.

"Drainage area" means a geographic area within which stormwater runoff, sediments, or dissolved materials drain to a particular receiving waterbody or to a particular point along a receiving waterbody.

"Environmentally critical area" means an area or feature which is of significant environmental value including but not limited to: stream corridors, natural heritage priority sites, habitats of endangered or threatened species, large areas of contiguous open space or upland forest, steep slopes, and well head protection and groundwater recharge areas. Habitats of endangered or threatened species are identified using the Department's Landscape Project as approved by the Department's Endangered and Nongame Species Program.

"Empowerment Neighborhoods" means neighborhoods designated by the Urban Coordinating Council "in consultation and conjunction with" the New Jersey Redevelopment Authority, pursuant to N.J.S.A. 55:19-69.

"Erosion" means the detachment and movement of soil or rock fragments by water, wind, ice, or gravity.

“Impervious surface” means a surface that has been covered with a layer of material so that it is highly resistant to infiltration by water.

“Infiltration” is the process by which water seeps into the soil from precipitation.

“Municipality” means any city, borough, town, township, or village.

“Node” means an area designated by the State Planning Commission concentrating facilities and activities that are not organized in a compact form.

“Nutrient” means a chemical element or compound, such as nitrogen or phosphorus, which is essential to and promotes the development of organisms.

"Person" means any individual, corporation, company, partnership, firm, association, or political subdivision of this State, or any state, interstate, or Federal agency.

“Pollutant” means any dredged spoil; solid waste; incinerator residue; filter backwash; sewage; garbage; refuse; oil; grease; sewage sludge; munitions; chemical waste; biological material; medical waste; radioactive substance (except those regulated under the Atomic Energy Act of 1954, as amended (42 U.S.C. §§2011 et seq.)); thermal waste; wrecked or discarded equipment; rock; sand; cellar dirt; industrial, municipal, agricultural, and construction waste or runoff; or other residue discharged directly or indirectly to the land, groundwaters, or surface waters of the State, or to a domestic treatment works. “Pollutant” includes both hazardous and nonhazardous pollutants.

"Recharge" means the amount of water from precipitation that infiltrates into the ground and is not evapotranspired.

“Sediment” means solid material, mineral or organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water, or gravity as a product of erosion.

“Site” means the lot or lots upon which a major development is to occur or has occurred.

“Soil” means all unconsolidated mineral and organic material of any origin.

“State Development and Redevelopment Plan Metropolitan Planning Area (PA1)” means an area delineated on the State Plan Policy Map and adopted by the State Planning Commission that is intended to be the focus for much of the State’s future redevelopment and revitalization efforts.

“State Plan Policy Map” is defined as the geographic application of the State Development and Redevelopment Plan’s goals and statewide policies, and the official map of these goals and policies.

“Stormwater” means water resulting from precipitation (including rain and snow) that runs off the land’s surface, is transmitted to the subsurface, or is captured by separate storm sewers or other sewage or drainage facilities, or conveyed by snow removal equipment.

“Stormwater runoff" means water flow on the surface of the ground or in storm sewers resulting from precipitation.

"Stormwater management basin" means an excavation or embankment and related areas designed to retain stormwater runoff. A stormwater management basin may either be normally dry (that is, a detention basin or infiltration basin), retain water in a permanent pool (a retention basin), or be planted mainly with wetland vegetation (most constructed stormwater wetlands).

"Stormwater management measure" means any structural or nonstructural strategy, practice, technology, process, program, or other method intended to control or reduce stormwater runoff and associated pollutants, or to induce or control the infiltration or groundwater recharge of

stormwater, or to eliminate illicit or illegal nonstormwater discharges into stormwater conveyances.

"Tidal Flood Hazard Area" means a flood hazard area which may be influenced by stormwater runoff from inland areas, but which is primarily caused by the Atlantic Ocean.

“Urban Coordinating Council Empowerment Neighborhood" means a neighborhood given priority access to State resources through the New Jersey Redevelopment Authority.

“Urban Enterprise Zone” means a zone designated by the New Jersey Urban Enterprise Zone Authority pursuant to the New Jersey Urban Enterprise Zones Act, N.J.S.A. 52:27H-60 et seq.

"Urban Redevelopment Areas" mean previously developed portions of areas:
1. Delineated on the State Plan Policy Map (SPPM) as Metropolitan Planning Area (PA1), Designated Centers, Cores, or Nodes;
2. Designated as CAFRA Centers, Cores, or Nodes;
3. Designated as Urban Enterprise Zones; and
4. Designated as Urban Coordinating Council Empowerment Neighborhoods.

“Waters of the State” means the ocean and its estuaries, all springs, streams, wetlands, and bodies of surface or groundwater, whether natural or artificial, within the boundaries of the State of New Jersey or subject to its jurisdiction.

"Wetlands" or "wetland” means an area that is inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions, commonly known as hydrophytic vegetation.

Subchapter 5: Design and Performance Standards for Stormwater Management Measures

7:8-5.1 Scope

(a) This subchapter establishes design and performance standards for stormwater management measures for major development intended to minimize the adverse impact of stormwater runoff on water quality and water quantity, and loss of groundwater recharge in receiving water bodies.

(b) The standards specified in this subchapter do not apply to major development if alternative design and performance standards that are at least as protective as would be achieved through this subchapter when considered on a regional stormwater management area basis are applicable under a regional stormwater management plan adopted in accordance with this chapter or a water quality management plan adopted in accordance with N.J.A.C. 7:15.

7:8-5.2 Stormwater Management Measures for Major Development

(a) Stormwater management measures for major development shall be developed to meet the erosion control, groundwater recharge, stormwater runoff quantity, and stormwater runoff quality standards at N.J.A.C. 7:8-5.4 and 5.5. To the maximum extent practicable, these standards shall be met by incorporating nonstructural stormwater management strategies at N.J.A.C. 7:8-5.3 into the design. If these measures alone are not sufficient to meet these standards, structural stormwater management measures at N.J.A.C. 7:8-5.7 necessary to meet these standards shall be incorporated into the design.

(b) The development shall incorporate a maintenance plan under N.J.A.C. 7:8-5.8 for the stormwater management measures.

(c) Stormwater management measures shall avoid adverse impacts of concentrated flow on habitat for threatened and endangered species as documented in the Department's Landscape Project or Natural Heritage Database established under N.J.S.A. 13:1B-15.147 through 15.150, particularly *Helonias bullata* (swamp pink) and/or *Clemmys muhlnebergi* (bog turtle).

(d) The following linear development projects are exempt from the ground water recharge, stormwater runoff quantity, and stormwater runoff quality requirements at N.J.A.C. 7:8-5.4 and 5.5:

1. The construction of an underground utility line provided that the disturbed areas are revegetated upon completion;

2. The construction of an aboveground utility line provided that the existing conditions are maintained to the maximum extent practicable; and

3. The construction of a public pedestrian access, such as a sidewalk or trail with a maximum width of 14 feet, provided that the access is made of permeable material.

(e) A waiver from strict compliance from the ground water recharge, stormwater runoff quantity, and stormwater runoff quality requirements at N.J.A.C. 7:8-5.4 and 5.5 may be obtained for the enlargement of an existing public roadway or railroad, or the construction or enlargement of a public pedestrian access, provided that the following conditions are met:

1. The applicant demonstrates that there is a public need for the project that cannot be accomplished by any other means;

2. The applicant demonstrates through an alternatives analysis that, through the use of nonstructural and structural stormwater management strategies and measures, the option selected complies with the requirements of N.J.A.C. 7:8-5.4 and 5.5 to the maximum extent practicable;

3. The applicant demonstrates that, in order to meet the requirements at N.J.A.C. 7:8-5.4 and 5.5, existing structures currently in use, such as homes and buildings, would need to be condemned; and

4. The applicant demonstrates that it does not own or have other rights to areas, including the potential to obtain through condemnation lands not falling under (e)3 above within the upstream drainage area of the receiving stream, that would provide additional opportunities to mitigate for requirements of N.J.A.C. 7:8-5.4 and 5.5 that were not achievable on site.

7:8-5.3 Nonstructural Stormwater Management Strategies

(a) To the maximum extent practicable, the standards in N.J.A.C. 7:8-5.4 and 5.5 shall be met by incorporating nonstructural stormwater management strategies at N.J.A.C. 7:8-5.3 into the design. The persons submitting an application for review shall identify the nonstructural strategies incorporated into the design of the project. If the applicant contends that it is not feasible for engineering, environmental, or safety reasons to incorporate any nonstructural stormwater management strategies identified in (b) below into the design of a particular project, the applicant shall identify the strategy and provide a basis for the contention.

(b) Nonstructural stormwater management strategies incorporated into site design shall:

1. Protect areas that provide water quality benefits or areas particularly susceptible to erosion and sediment loss;

2. Minimize impervious surfaces and break up or disconnect the flow of runoff over impervious surfaces;

3. Maximize the protection of natural drainage features and vegetation;

4. Minimize the decrease in the "time of concentration" from pre-construction to post-construction. "Time of concentration" is defined as the time it takes for runoff to travel from the hydraulically most distant point of the drainage area to the point of interest within a watershed;

5. Minimize land disturbance, including clearing and grading;

6. Minimize soil compaction;

7. Provide low-maintenance landscaping that encourages retention and planting of native vegetation, and minimizes the use of lawns, fertilizers, and pesticides;

8. Provide vegetated open-channel conveyance systems discharging into and through stable vegetated areas; and

9. Provide other source controls to prevent or minimize the use or exposure of pollutants at the site in order to prevent or minimize the release of those pollutants into stormwater runoff. These source controls include, but are not limited to:

   i. Site design features that help to prevent accumulation of trash and debris in drainage systems;

   ii. Site design features that help to prevent discharge of trash and debris from drainage systems;

   iii. Site design features that help to prevent and/or contain spills or other harmful accumulations of pollutants at industrial or commercial developments; and

   iv. When establishing vegetation after land disturbance, applying fertilizer in accordance with the requirements established under the Soil Erosion and Sediment Control Act, N.J.S.A. 4:24-39 et seq., and implementing rules.

(c) Any land area used as a nonstructural stormwater management measure to meet the performance standards in N.J.A.C. 7:8-5.4 and 5.5 shall be dedicated to a government agency, subjected to a conservation restriction filed with the county clerk's office, or subject to Department approved or equivalent restriction that ensures that measure, or an equivalent stormwater management measure approved by the reviewing agency, is maintained in perpetuity.

(d) Guidance for nonstructural stormwater management strategies is available in the *New Jersey Stormwater Best Management Practices Manual* available from the Department through the address listed at N.J.A.C. 7:8-1.3.

7:8-5.4 Erosion Control, Ground Water Recharge, and Runoff Quantity Standards

(a) This section contains minimum design and performance standards to control erosion, encourage and control infiltration and ground water recharge, and control stormwater runoff quantity impacts of major development.

1. The minimum design and performance standards for erosion control are those established under the Soil Erosion and Sediment Control Act, N.J.S.A. 4:24-39 et seq., and implementing rules.

2. The minimum design and performance standards for ground water recharge are as follows:

i. The design engineer shall, using the assumptions and factors for stormwater runoff and ground water recharge calculations at N.J.A.C. 7:8-5.6, either:

(1) Demonstrate through hydrologic and hydraulic analysis that the site and its stormwater management measures maintain 100 percent of the average annual pre-construction ground water recharge volume for the site; or

(2) Demonstrate through hydrologic and hydraulic analysis that the increase of stormwater runoff volume from pre-construction to post-construction for the two-year storm is infiltrated.

ii. This ground water recharge requirement does not apply to projects within the "urban redevelopment area" or to projects subject to (a)2.iii below.

iii. The following types of stormwater shall not be recharged:

(1) Stormwater from areas of high-pollutant loading. High-pollutant loading areas are areas in industrial and commercial developments where solvents and/or petroleum products are loaded/unloaded, stored, or applied; areas where pesticides are loaded/unloaded or stored; areas where hazardous materials are expected to be present in greater than 'reportable quantities' as defined by the United States Environmental Protection Agency (EPA) at 40 CFR 302.4; areas where recharge would be inconsistent with a Department-approved remedial action work plan or landfill closure plan; and areas with high risks for spills of toxic materials, such as gas stations and vehicle maintenance facilities; and

(2) Industrial stormwater exposed to "source material." "Source material" means any material(s) or machinery located at an industrial facility that is directly or indirectly related to process, manufacturing, or other industrial activities, which could be a source of pollutants in any industrial stormwater discharge to ground water. Source materials include, but are not limited to, raw materials; intermediate products; final products; waste materials; by-products; industrial machinery and fuels; and lubricants, solvents, and detergents that are related to process, manufacturing, or other industrial activities that are exposed to stormwater.

iv. The design engineer shall assess the hydraulic impact on the ground water table and design the site so as to avoid adverse hydraulic impacts. Potential adverse hydraulic impacts include, but are not limited to,

exacerbating a naturally or seasonally high water table so as to cause surficial ponding, flooding of basements, or interference with the proper operation of subsurface sewage disposal systems and other subsurface structures in the vicinity or downgradient of the ground water recharge area.

3. In order to control stormwater runoff quantity impacts, the design engineer shall, using the assumptions and factors for stormwater runoff calculations at N.J.A.C. 7:8-5.6, complete one of the following:

   i. Demonstrate through hydrologic and hydraulic analysis that, for stormwater leaving the site, post-construction runoff hydrographs for the 2-, 10-, and 100-year storm events do not exceed, at any point in time, the pre-construction runoff hydrographs for the same storm events;

   ii. Demonstrate through hydrologic and hydraulic analysis that there is no increase, as compared to the pre-construction condition, in the peak runoff rates of stormwater leaving the site for the 2-, 10-, and 100-year storm events, and that the increased volume or change in timing of stormwater runoff will not increase flood damage at or downstream of the site. This analysis shall include the analysis of impacts of existing land uses and projected land uses, assuming full development under existing zoning and land-use ordinances in the drainage area;

   iii. Design stormwater management measures so that the post-construction peak runoff rates for the 2-, 10-, and 100-year storm events are 50, 75, and 80 percent, respectively, of the pre-construction peak runoff rates. The percentages apply only to the post-construction stormwater runoff that is attributable to the portion of the site on which the proposed development or project is to be constructed; or

   iv. In tidal flood hazard areas, stormwater runoff quantity analysis in accordance with (a)3.i, ii, and iii above shall only be applied if the increased volume of stormwater runoff could increase flood damages below the point of discharge.

(b) Any application for a new agricultural development that meets the definition of major development at N.J.A.C. 7:8-1.2 shall be submitted to the Soil Conservation District for review and approval, in accordance with the requirements of this section and any applicable Soil Conservation District guidelines for stormwater runoff quantity and erosion control. For purposes of this section, “agricultural development” means land uses normally associated with the production of food, fiber, and livestock for sale. Such uses do not include the development of land for the processing or sale of food and the manufacture of agriculturally related products.

7:8-5.5 Stormwater Runoff Quality Standards

(a) Stormwater management measures shall be designed to reduce the post-construction load of total suspended solids (TSS) in stormwater runoff generated from the water quality design storm by 80 percent of the anticipated load from the developed site, expressed as an annual average. Stormwater management measures shall only be required for water quality control if an additional one-quarter acre of impervious surface is being proposed on a development site. *(Department of Community Affairs Note: Consistent with N.J.A.C. 7:8-4.2, Municipal Stormwater Management Plan and Elements, the Residential Site Improvement Standards requirements are only triggered by residential developments that disturb one or more acres of land.)* The requirement to reduce TSS does not apply to any stormwater runoff in a discharge regulated under a numeric effluent limitation for TSS imposed under the New Jersey Pollutant Discharge

Elimination System (NJPDES) rules, N.J.A.C. 7:14A, or in a discharge specifically exempt under a NJPDES permit from this requirement. The water quality design storm is 1.25 inches of rainfall in two hours. Water quality calculations shall take into account the distribution of rain from the water quality design storm, as reflected in Table 1 below. The calculation of the volume of runoff may take into account the implementation of nonstructural and structural stormwater management measures.

TABLE 1: WATER QUALITY DESIGN STORM DISTRIBUTION

Time (Minutes)	Cumulative Rainfall (Inches)	Time (Minutes)	Cumulative Rainfall (Inches)
0	0.0000	65	0.8917
5	0.0083	70	0.9917
10	0.0166	75	1.0500
15	0.0250	80	1.0840
20	0.0500	85	1.1170
25	0.0750	90	1.1500
30	0.1000	95	1.1750
35	0.1330	100	1.2000
40	0.1660	105	1.2250
45	0.2000	110	1.2334
50	0.2583	115	1.2417
55	0.3583	120	1.2500
60	0.6250		

(b) For purposes of TSS reduction calculations, Table 2 below presents the presumed removal rates for certain BMPs designed in accordance with the *New Jersey Stormwater Best Management Practices Manual*. The *BMP Manual* may be obtained from the address identified in N.J.A.C. 7:8-1.3, or found on the Department's web site at www.njstormwater.org. The *BMP Manual* and other sources of technical guidance are listed in N.J.A.C. 7:8-5.9(a). TSS reduction shall be calculated based on the removal rates for the BMPs in Table 2 below. Alternative removal rates and methods of calculating removal rates may be used if the design engineer provides documentation demonstrating the capability of these alternative rates and methods to the review agency. Where the Department is not the review agency, a copy of any approved alternative rate or method of calculating the removal rate shall be provided to the Department at the address at N.J.A.C. 7:8-1.3.

(c) If more than one BMP in series is necessary to achieve the required 80 percent TSS reduction for a site, the applicant shall utilize the following formula to calculate TSS reduction:

$$R = A + B – (AXB)/100$$

where

R = total TSS percent load removal from application of both BMPs, and

A = the TSS percent removal rate applicable to the first BMP

B = the TSS percent removal rate applicable to the second BMP

TABLE 2: TSS REMOVAL RATES FOR BMPs

Best Management Practice	TSS Percent Removal Rate
Bioretention Systems	90
Constructed Stormwater Wetland	90
Extended Detention Basin	40-60
Infiltration Structure	80
Manufactured Treatment Device	See N.J.A.C. 7:8-5.7(d)
Sand Filter	80
Vegetative Filter Strip	60-80
Wet Pond	50-90

(d) If there is more than one on-site drainage area, the 80 percent TSS removal rate shall apply to each drainage area, unless the runoff from the subareas converge on site, in which case the removal rate can be demonstrated through a calculation using a weighted average.

(e) Stormwater management measures shall also be designed to reduce, to the maximum extent feasible, the post-construction nutrient load of the anticipated load from the developed site in stormwater runoff generated from the water quality design storm. In achieving reduction of nutrients to the maximum extent feasible, the design of the site shall include nonstructural strategies and structural measures that optimize nutrient removal while still achieving the performance standards in N.J.A.C. 7:8-5.4 and 5.5.

(f) Additional information and examples are contained in the *New Jersey Stormwater Best Management Practices Manual*, which may be obtained from the address identified in N.J.A.C. 7:8-1.3.

(g) In accordance with the definition of FW1 at N.J.A.C. 7:9B-1.4, stormwater management measures shall be designed to prevent any increase in stormwater runoff to waters classified as FW1.

(h) Special water resource protection areas shall be established along all waters designated Category One at N.J.A.C. 7:9B and perennial or intermittent streams that drain into or upstream of the Category One waters, as shown on the USGS Quadrangle Maps or in the County Soil Surveys, within the associated HUC 14 drainage. These areas shall be established for the protection of water quality, aesthetic value, exceptional ecological significance, exceptional recreational significance, exceptional water supply significance, and exceptional fisheries significance of those established Category One waters. These areas shall be designated and protected as follows:

1. The applicant shall preserve and maintain a special water resource protection area in accordance with one of the following:

   i. A 300-foot special water resource protection area shall be provided on each side of the waterway, measured perpendicular to the waterway from the top of bank outwards, or from the centerline of the waterway where the bank is not defined, consisting of existing vegetation or vegetation allowed to follow natural succession.

   ii. Encroachment within the designated special water resource protection area under (h)1.i above shall only be allowed where previous

development or disturbance has occurred (for example, active agricultural use, parking area, or maintained lawn area). The encroachment shall only be allowed where applicant demonstrates that the functional value and overall condition of the special water resource protection area will be maintained to the maximum extent practicable. In no case shall the remaining special water resource protection area be reduced to less than 150 feet as measured perpendicular to the top of bank of the waterway or centerline of the waterway where the bank is undefined. All encroachments proposed under this subparagraph shall be subject to review and approval by the Department.

2. All stormwater shall be discharged outside of, but may flow through, the special water resource protection area, and shall comply with the Standard for Off-Site Stability in the *Standards for Soil Erosion and Sediment Control in New Jersey*, established under the Soil Erosion and Sediment Control Act, N.J.S.A. 4:24-39 et seq. (see N.J.A.C. 2:90-1.3).

3. If stormwater discharged outside of and flowing through the special water resource protection area cannot comply with the Standard for Off-Site Stability in the *Standards for Soil Erosion and Sediment Control in New Jersey*, established under the Soil Erosion and Sediment Control Act, N.J.S.A. 4:24-39 et seq., (see N.J.A.C. 2:90-1.3), then the stabilization measures in accordance with the requirements of the above standards may be placed within the special water resource protection area, provided that:

   i. Stabilization measures shall not be placed within 150 feet of the waterway;

   ii. Stormwater associated with discharges allowed by this paragraph shall achieve a 95 percent TSS post-construction removal rate;

   iii. Temperature shall be addressed to ensure no impact on receiving waterway;

   iv. The encroachment shall only be allowed where the applicant demonstrates that the functional value and overall condition of the special water resource protection area will be maintained to the maximum extent practicable;

   v. A conceptual project design meeting shall be held with the appropriate Department staff and Soil Conservation District staff to identify necessary stabilization measures; and

   vi. All encroachments proposed under this section shall be subject to review and approval by the Department.

4. A stream corridor protection plan may be developed by a regional stormwater management planning committee, as an element of a regional stormwater management plan, or by a municipality through an adopted municipal stormwater management plan. If a stream corridor protection plan for a waterway subject to this subsection has been approved by the Department, then the provisions of the plan shall be the applicable special water resource protection area requirements for that waterway. A stream corridor protection plan for a waterway subject to this subsection shall maintain or enhance the current functional value and overall condition of the special water resource protection area as defined above in (h)1.i. In no case shall a stream corridor protection plan allow reduction of the special water resource protection area to less than 150 feet as measured perpendicular to the waterway subject to this subsection.

5. This subsection does not apply to the construction of one individual, single-family dwelling that is not part of a larger development on a lot receiving preliminary or final subdivision approval on or before February 2, 2004, provided that the construction begins on or before February 2, 2009.

7:8-5.6 Calculation of Stormwater Runoff and Ground Water Recharge

(a) Stormwater runoff shall be calculated in accordance with the following:

1. The design engineer shall calculate runoff using one of the following methods:

i. The USDA Natural Resources Conservation Service (NRCS) methodology, including the NRCS Runoff Equation and Dimensionless Unit Hydrograph, as described in Section 4, *National Engineering Handbook (NEH-4)*, dated July 2002, incorporated herein by reference as amended and supplemented. This methodology is additionally described in *Technical Release No. 55 (TR-55), Urban Hydrology for Small Watersheds*, dated June 1986, incorporated herein by reference as amended and supplemented. Information regarding the methodology is available from the Natural Resources Conservation Service web site at http://www.wcc.nrcs.usda.gov/water/quality/common/neh630/4content.html or at Natural Resources Conservation Service, 220 Davidson Avenue, Somerset, New Jersey 08873, (732) 537-6040; or

ii. The Rational Method for peak flow and the Modified Rational Method for hydrograph computations. The rational and modified rational methods are described in “Appendix A-9, Modified Rational Method” in the *Standards for Soil Erosion and Sediment Control in New Jersey*, July 1999. This document is available from the State Soil Conservation Committee or any of the Soil Conservation Districts listed at N.J.A.C. 2:90-1.3(a)4. The location, address, and telephone number of each Soil Conservation District is available from the State Soil Conservation Committee, Post Office Box 330, Trenton, New Jersey 08625, (609) 292-5540.

2. For the purpose of calculating runoff coefficients and ground water recharge, there is a presumption that the pre-construction condition of a site or portion thereof is a wooded land use with good hydrologic condition. The term "runoff coefficient" applies to both the NRCS methodology at N.J.A.C. 7:8-5.6(a)1.i, and the Rational and Modified Rational Methods at N.J.A.C. 7:8-5.6(a)1.i. A runoff coefficient, or a ground water recharge land cover for an existing condition, may be used on all or a portion of the site if the design engineer verifies that the hydrologic condition has existed on the site or portion of the site for at least five years without interruption prior to the time of application. If more than one land cover have existed on the site during the five years immediately prior to the time of application, the land cover with the lowest runoff potential shall be used for the computations. In addition, there is the presumption that the site is in good hydrologic condition (if the land-use type is pasture, lawn, or park), with good cover (if the land-use type is woods), or with good hydrologic condition and conservation treatment (if the land-use type is cultivation).

3. In computing pre-construction stormwater runoff, the design engineer shall account for all significant land features and structures, such as ponds, wetlands, depressions, hedgerows, or culverts, that may reduce pre-construction stormwater runoff rates and volumes.

4. In computing stormwater runoff from all design storms, the design engineer shall consider the relative stormwater runoff rates and/or volumes of pervious and

impervious surfaces separately to accurately compute the rates and volume of stormwater runoff from the site. To calculate runoff from unconnected impervious cover, urban impervious area modifications as described in NRCS *Technical Release No. 55, Urban Hydrology for Small Watersheds*, or other methods may be employed.

5. If the invert of the outlet structure of a stormwater management measure is below the flood hazard design flood elevation as defined at N.J.A.C. 7:13, the design engineer shall take into account the effects of tailwater in the design of structural stormwater management measures.

(b) Groundwater recharge may be calculated in accordance with the following:

1. The New Jersey Geological Survey's *Geological Survey Report, GSR-32, A Method for Evaluating Ground Water Recharge Areas in New Jersey*, incorporated herein by reference as amended and supplemented. Information regarding the methodology is available from the *New Jersey Stormwater Best Management Practices Manual*; at the New Jersey Geological Survey web site at http://www.state.nj.us/dep/njgs/; or at the New Jersey Geological Survey, 29 Arctic Parkway, Post Office Box 427, Trenton, New Jersey 08625-0427, (609) 984-6587.

7:8-5.7 Standards for Structural Stormwater Management Measures

(a) Standards for structural stormwater management measures are as follows:

1. Structural stormwater management measures shall be designed to take into account the existing site conditions, including, for example, environmentally critical areas; wetlands; flood-prone areas; slopes; depth to seasonal high water table; soil type, permeability and texture; drainage area and drainage patterns; and the presence of solution-prone carbonate rocks (limestone).

2. Structural stormwater management measures shall be designed to minimize maintenance, facilitate maintenance and repairs, and ensure proper functioning. Trash racks shall be installed at the intake to the outlet structure as appropriate, and shall have parallel bars with one-inch spacing between the bars to the elevation of the water quality design storm. For elevations higher than the water quality design storm, the parallel bars at the outlet structure shall be spaced no greater than one-third the width of the diameter of the orifice or one-third the width of the weir, with a minimum spacing between bars of one inch and a maximum spacing between bars of six inches. In addition, the design of trash racks must comply with the requirements of N.J.A.C. 7:8-6.2(a).

3. Structural stormwater management measures shall be designed, constructed, and installed to be strong, durable, and corrosion resistant. Measures that are consistent with the relevant portions of the Residential Site Improvement Standards at N.J.A.C. 5:21-7.3, 7.4, and 7.5 shall be deemed to meet this requirement.

4. At the intake to the outlet from the stormwater management basin, the orifice size shall be a minimum of two and one-half inches in diameter.

5. Stormwater management basins shall be designed to meet the minimum safety standards for stormwater management basins at N.J.A.C. 7:8-6.

(b) Stormwater management measure guidelines are available in the *New Jersey Stormwater Best Management Practices Manual*. Other stormwater management measures may be utilized provided the design engineer demonstrates that the proposed

measure and its design will accomplish the required water quantity, ground water recharge, and water quality design and performance standards established by this subchapter.

(c) Manufactured treatment devices may be used to meet the requirements of this subchapter, provided the pollutant removal rates are verified by the New Jersey Corporation for Advanced Technology and certified by the Department.

7:8-5.8 Maintenance Requirements

(a) The design engineer shall prepare a maintenance plan for the stormwater management measures incorporated into the design of a major development.

(b) The maintenance plan shall contain specific preventative maintenance tasks and schedules; cost estimates including estimated cost of sediment, debris, or trash removal; and the name, address, and telephone number of the person or persons responsible for preventative and corrective maintenance (including replacement). Maintenance guidelines for stormwater management measures are available in the *New Jersey Stormwater Best Management Practices Manual*. If the maintenance plan identifies a person other than the developer (for example, a public agency or homeowners association) as having the responsibility for maintenance, the plan shall include documentation of such person's agreement to assume this responsibility, or of the developer's obligation to dedicate a stormwater management facility to such person under an applicable ordinance or regulation.

(c) Responsibility for maintenance shall not be assigned or transferred to the owner or tenant of an individual property in a residential development or project, unless such owner or tenant owns or leases the entire residential development or project.

(d) If the person responsible for maintenance identified under (b) above is not a public agency, the maintenance plan and any future revisions based on (h) below shall be recorded upon the deed of record for each property on which the maintenance described in the maintenance plan must be undertaken.

(e) Preventative and corrective maintenance shall be performed to maintain the function of the stormwater management measure including repairs or replacement to the structure; removal of sediment, debris, or trash; restoration of eroded areas; snow and ice removal; fence repair or replacement; restoration of vegetation; and repair or replacement of nonvegetated linings.

(f) The person responsible for maintenance identified under (b) above shall maintain a detailed log of all preventative and corrective maintenance for the structural stormwater management measures incorporated into the design of the development, including a record of all inspections and copies of all maintenance-related work orders.

(g) The person responsible for maintenance identified under (b) above shall evaluate the effectiveness of the maintenance plan at least once per year, and adjust the plan and the deed as needed.

(h) The person responsible for maintenance identified under (b) above shall retain and make available, upon request by any public entity with administrative, health, environmental, or safety authority over the site, the maintenance plan and the documentation required by (f) and (g) above.

(i) Nothing in this section shall preclude the municipality in which the major development is located from requiring the posting of a performance or maintenance guarantee in accordance with N.J.S.A. 40:55D-53.

7:8-5.9 Sources for Technical Guidance

(a) Technical guidance for stormwater management measures can be found in the documents listed at (a)1 and 2 below, which are available from Maps and Publications, New Jersey Department of Environmental Protection, 428 East State Street, Post Office Box 420, Trenton, New Jersey 08625, (609) 777-1038.

1. Guidelines for stormwater management measures are contained in the *New Jersey Stormwater Best Management Practices Manual,* 2002 as amended. *(Department of Community Affairs Note: The effective version of the* New Jersey Stormwater Best Management Practices Manual *is the April 2004 edition.)* Information is provided on stormwater management measures such as:

i. Bioretention systems;

ii. Constructed stormwater wetlands;

iii. Dry wells;

iv. Extended detention basins;

v. Infiltration structures;

vi. Manufactured treatment devices;

vii. Pervious paving;

viii. Sand filters;

ix. Vegetative filter strip; and

x. Wet pond.

2. *The New Jersey Department of Environmental Protection Stormwater Management Facilities Maintenance Manual*, as amended.

(b) Additional technical guidance for stormwater management measures can be obtained from the following:

1. *The Standards for Soil Erosion and Sediment Control in New Jersey* promulgated by the State Soil Conservation Committee and incorporated into N.J.A.C. 2:90. Copies of these standards may be obtained by contacting the State Soil Conservation Committee or any of the Soil Conservation Districts listed in N.J.A.C. 2:90-1.3(a)4. The location, address, and telephone number of each Soil Conservation District may be obtained from the State Soil Conservation Committee, Post Office Box 330, Trenton, New Jersey 08625, (609) 292-5540.

2. The Rutgers Cooperative Extension Service, (732) 932-9306.

3. The Soil Conservation Districts listed in N.J.A.C. 2:90-1.3(a)4. The location, address, and telephone number of each Soil Conservation District may be obtained from the State Soil Conservation Committee, Post Office Box 330, Trenton, New Jersey 08625, (609) 292-5540.

Subchapter 6: Safety Standards for Stormwater Management Basins

7:8-6.1 Scope

(a) This subchapter sets forth requirements to protect public safety through the proper design and operation of stormwater management basins. This subchapter applies to any new stormwater management basin.

(b) The provisions of this subchapter are not intended to preempt more stringent municipal or county safety requirements for new or existing stormwater management basins. Municipal and county stormwater management plans and ordinances may, pursuant to their authority, require existing stormwater management basins to be retrofitted to meet one or more of the safety standards in N.J.A.C. 7:8-6.2(a), (b), and (c)1 for trash racks, overflow grates, and escape provisions at outlet structures.

7:8-6.2 Requirements for Trash Racks, Overflow Grates, and Escape Provisions

(a) A trash rack is a device designed to catch trash and debris, and prevent the clogging of outlet structures. Trash racks shall be installed at the intake to the outlet from the stormwater management basin to ensure proper functioning of the basin outlets in accordance with the following:

1. The trash rack shall have parallel bars, with no greater than six-inch spacing between the bars.

2. The trash rack shall be designed so as not to adversely affect the hydraulic performance of the outlet pipe or structure.

3. The average velocity of flow through a clean trash rack is not to exceed 2.5 feet per second under the full range of stage and discharge. Velocity is to be computed on the basis of the net area of opening through the rack.

4. The trash rack shall be constructed of rigid, durable, and corrosion-resistant material, and designed to withstand a perpendicular live loading of 300 lbs./ft sq.

(b) An overflow grate is designed to prevent obstruction of the overflow structure. If an outlet structure has an overflow grate, the grate shall comply with the following requirements:

1. The overflow grate shall be secured to the outlet structure, but removable for emergencies and maintenance;

2. The overflow grate spacing shall be no greater than two inches across the smallest dimension; and

3. The overflow grate shall be constructed of rigid, durable, and corrosion-resistant material, and designed to withstand a perpendicular live loading of 300 lbs./ft sq.

(c) Stormwater management basins shall include escape provisions as follows:

1. If a stormwater management basin has an outlet structure, escape provisions shall be incorporated in or on the structure. Escape provisions include the installation of permanent ladders, steps, rungs, or other features that provide easily accessible means of egress from stormwater management basins. With the prior approval of the reviewing agency pursuant to N.J.A.C. 7:8-6.3(a), a free-standing outlet structure may be exempted from this requirement.

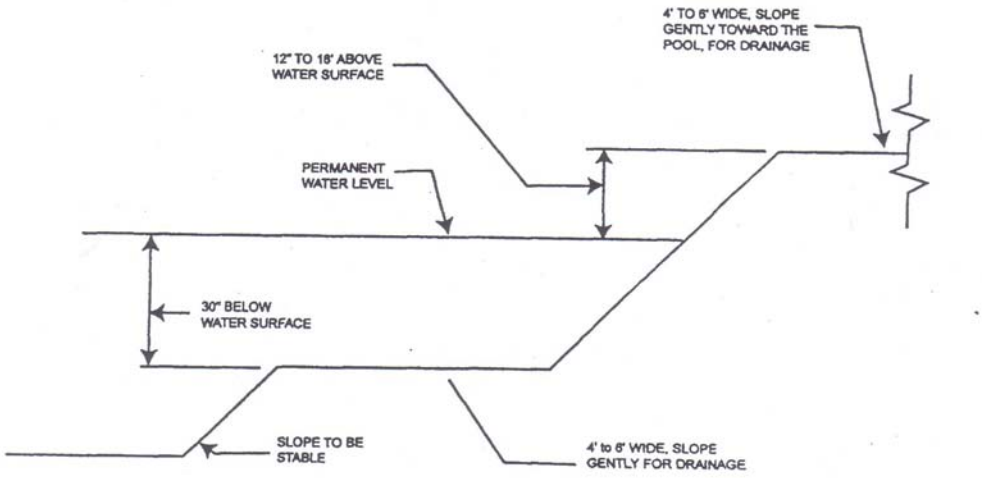
2. Safety ledges shall be constructed on the slopes of all new stormwater management basins having a permanent pool of water deeper than two and one-half feet. Safety ledges shall be comprised of two steps. Each step shall be four to six feet in width. One step shall be located approximately two and one-half feet below the permanent water surface, and the second step shall be located one to one and one-half feet above the permanent water surface. See N.J.A.C. 7:8-6, Appendix A for an illustration of safety ledges in a stormwater management basin.

3. In new stormwater management basins, the maximum interior slope for an earthen dam, embankment, or berm shall not be steeper than three horizontal to one vertical.

7:8-6.3 Variance or Exemption from Safety Standards

A variance or exemption from the safety standards for stormwater management basins may be granted only upon a written finding by the appropriate reviewing agency (municipality, county, or Department) that the variance or exemption will not constitute a threat to public safety.

Appendix A: Illustration of safety ledges in a new detention basin. Depicted is an elevational view.



NOTE: NOT DRAWN TO SCALE

NOTE: FOR BASINS WITH PERMANENT POOL OF WATER ONLY